



Short Communication

Effects of post-discharge counseling and medication utilization on short and long-term smoking cessation among hospitalized patients

Edward P. Liebmann^a, Kimber P. Richter^b, Taneisha Scheuermann^b, Babalola Faseru^{b,*}^a University of Kansas, Department of Psychology, 1415 Jayhawk Blvd., Fraser Hall, Room 426, Lawrence, KS 66045, USA^b University of Kansas Medical Center, Department of Population Health, Mailstop 1008, 3901 Rainbow Blvd., Kansas City, KS 66160, USA

ARTICLE INFO

Keywords:

Smoking cessation
Hospitalized patients
Counseling
Pharmacotherapy
Quit line utilization
Post-discharge
Warm handoff
Fax-referral

ABSTRACT

Numerous studies have tested the effect of multicomponent post-discharge smoking cessation interventions on post-discharge smoking cessation, and many are effective. However, little is known regarding the relative efficacy of the different intervention components on short or long-term cessation. The present study is a secondary analysis ($n = 984$) of a randomized controlled trial for hospitalized smokers that took place at two large hospitals in Kansas from 2011 to 2014. All study participants were offered post-discharge quitline services. Pharmacotherapy was recommended during bedside tobacco treatment. The study outcomes were self-reported cessation at 1-month and biochemically verified cessation at 6-months post-randomization. During the post-discharge period, 69% of participants completed at least one quitline call and 28% of participants reported using cessation pharmacotherapy. After controlling for known predictors of cessation among hospitalized smokers, both the number of total quitline calls completed post-discharge and use of cessation pharmacotherapy post-discharge were predictive of cessation at 1-month. After accounting for predictors of cessation and quitting at 1-month, total post-discharge quitline calls was associated with cessation at 6-months ($OR [95\% CI] = 1.23 [1.12, 1.35], p < 0.001$) while post-discharge cessation pharmacotherapy use was not. The results suggest that both engagement in quitline services and use pharmacotherapy independently facilitate cessation beyond the influence of known clinical characteristics associated with cessation. Over the longer term, the effect of engaging in quitline services persists while the effect of pharmacotherapy diminishes. To optimize outcomes, future research should investigate methods to increase utilization of medications and promote sustained counseling engagement in order to sustain the effects of treatment during the post-discharge period.

1. Introduction

An estimated 7 million tobacco users are admitted to hospitals in the U.S. annually (CDC 2010; Wier et al., 2011), and hospitalization has proved to be an effective setting for treating tobacco dependence (Rigotti et al., 2012). Few hospitals treat tobacco dependence (Freund et al., 2008), although effective interventions exist (Rigotti et al., 2012). To be effective, it is critically important for hospitals to provide post-discharge tobacco treatment that includes at least one month of supportive counseling (Wier et al., 2011). Providing smoking cessation medications for patients as an adjunct to counseling significantly improves long term quit rates (Fiore et al., 2008). A number of studies have examined methods for implementing these two elements of care into hospital treatment and post-discharge care planning (Sherman et al., 2016; Rigotti et al., 2016; Rigotti and Stoney, 2016; Richter et al., 2016; Harrington et al., 2016; Fellows et al., 2016; Duffy et al., 2016;

Cummins et al., 2016).

Post-discharge smoking cessation treatment providing automated telephone interactive voice response (IVR) counseling calls and free medication increased biochemically verified quit rates by almost two-fold (26% vs. 15%; $RR 1.71, 95\% CI, 1.14-2.56$) in a single site study. This study targeted all hospitalized patients (Rigotti et al., 2014). However, in a multi-site study that incorporated the IVR-to quitline transfer to test the scalability of this approach, the difference in cessation rates was statistically significant at 3 months but not at 6 months after hospital discharge (Rigotti et al., 2016). Few hospital-initiated interventions have evaluated the relative and independent contribution of individual features of multi-component interventions. Cummins et al. (2016) used a factorial design to evaluate the effects of post-discharge quitline and nicotine replacement on self-reported cessation at 6 months. They observed a marginal effect ($p = 0.051$) for post-discharge pharmacotherapy on 6-month cessation and a non-significant

* Corresponding author.

E-mail address: bfaseru@kumc.edu (B. Faseru).<https://doi.org/10.1016/j.pmedr.2019.100937>

Received 19 November 2018; Received in revised form 21 June 2019; Accepted 27 June 2019

Available online 29 June 2019

2211-3355/ © 2019 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

effect for quitline counseling. Simon (Simon et al., 1997) conducted an RCT of a multicomponent intervention including inpatient counseling, self-help materials, NRT and 3 months of telephone counseling post-discharge vs. self-help materials only. Quit rates were higher in the intervention group. Approximately 65% participants in the intervention arm and nearly 20% in the self-help only arm reported using NRT, however, NRT use was not significantly associated with quitting.

A better understanding of exactly what components post-discharge treatment should consist of would assist with developing better interventions. The focus of this study is to determine the independent effects of post-discharge counseling versus pharmacotherapy for cessation among participants in a study of hospital-initiated smoking cessation. Our analyses examine the effects of each on short and long-term abstinence. We also adjust for the effects of short-term abstinence in order to pinpoint the predictors of long-term abstinence.

2. Methods

2.1. Design and setting

This study is a secondary analysis of data from a clinical trial in which hospitalized smokers were randomized to either warm handoff or fax-referral to state tobacco quitline services for post-discharge treatment (Richter et al., 2016; Richter et al., 2012). State quitlines are effective in helping smokers quit (Stead et al., 2013). The fax-referral arm was the usual tobacco treatment care provided by the hospital tobacco treatment staff. It consisted of a) assessing withdrawal; b) adjusting inpatient nicotine replacement to enhance patient comfort; c) arranging medication prescriptions on discharge; and d) developing a quit plan. Staff fax-referred patients to the quitline on the day they were discharged from the hospital. In the warm handoff arm, staff conducted usual care steps a-c, then immediately linked patients with the quitline via telephone for registration and completion of a quit plan with the quitline provider. Alere Wellbeing provided quitline counseling, which consisted of 5 proactive calls that addressed motivation, barriers, and strategies for quitting and staying quit. Participants were enrolled in two Kansas hospitals with dedicated tobacco treatment interventionists on staff. Informed consent was obtained for all participants. The institutional review boards at both hospitals approved study protocols and measures.

2.2. Participants and procedures

Hospitalized patients who were 18 years and older, smoked at least 1 cigarette within the past 30 days and were planning to stay quit post-discharge were enrolled in the study (Richter et al., 2016; Richter et al., 2012). Tobacco users were identified through the electronic health record (EHR) and consented at bedside. The fax-referral arm was the usual care provided by the hospital tobacco treatment staff. Counseling was provided in one session and consisted of a) assessing withdrawal; b) adjusting inpatient nicotine replacement to enhance patient comfort; c) arranging medication prescriptions on discharge; and d) developing a quit plan. In fax-referral, counselors faxed an enrollment form to the quitline upon patient discharge, and the quitline contacted patients at home to enroll patients in services.

In the warm handoff arm, staff conducted usual care steps a-c, then called the state tobacco quitline and transferred the call to the patients' mobile or bedside hospital phone for enrollment and an initial counseling session. Alere Wellbeing (now Optum) provided quitline counseling, which consisted of 5 proactive calls that addressed motivation, barriers, and strategies for quitting and staying quit.

No medications were directly provided as part of the study and prescribing hospital physicians were not part of the study team. However, tobacco treatment in both study arms involved gauging patients' interest in smoking cessation medications. For interested patients, counselors worked with patients' hospital medical teams to

arrange medication scripts both in the hospital and on discharge. Additional detail on study procedures are provided elsewhere (Richter et al., 2016; Richter et al., 2012).

2.3. Measures

Total quitline counseling calls for each participant were provided by Optum, the state quitline contractor. Self-reported smoking cessation medication use (nicotine replacement therapy, varenicline, bupropion) at one-month post-discharge was collected from participants via telephone survey at 1-month. The baseline study survey included race and ethnicity, highest level of education, Heaviness of Smoking Index (HSI) (Heatherton et al., 1989), confidence in quitting/staying quit, previous use of smoking cessation medications and other tobacco products. Confidence in quitting was assessed using a single item: "How confident are you that you will be able to quit/stay quit once you are discharged from the hospital?" The item was scored on a 1 (*Not at all confident*) to 5 (*Very confident*) Likert scale. The AUDIT-C (Bush et al., 1998), a 3-item measure, was used to assess problem drinking.

In addition, key study data were collected from the EHR. These included: birth date; sex; health insurance; length of stay; whether admission was through the emergency department (ED); and ICD-9 codes for primary and secondary discharge diagnoses. Primary diagnoses were grouped into the major ICD-9 categories. We used a defined list of ICD-9 codes to identify patients with tobacco-related diseases (Lando et al., 2003). Primary or secondary psychiatric disorders were indicated by ICD-9 codes 290-319, excluding 305.1 for tobacco use disorder.

The dependent variables were self-reported 7-day point prevalent abstinence at 1-month (7DPP) and biochemically verified abstinence 7-day point prevalence at 6-months. Self-reported abstinence was assessed during the 1-month telephone survey. Abstinence at 6-months was verified via salivary cotinine. Participants with ≤ 15 ng/ml salivary cotinine were considered abstinent. Expired carbon monoxide (CO), with a cut-off point of 10 ppm was used to verify abstinence in participants still using NRT (SRNT, 2002).

2.4. Statistical analysis

Nine-hundred eighty-four of the original 1054 participants were included in the present analysis (93.4% of all participants). Participants ($n = 70$) who were missing at both 1-month and 6-month follow-ups were excluded. Participants included in this study ($n = 984$) were compared to participants lost to follow-up ($n = 70$) on all baseline characteristics. The participants who were lost to follow-up were significantly less likely to have health insurance (84.1% vs. 94.3%, $p = 0.002$), less likely to be at-risk drinkers (14.5% vs. 31.7%, $p = 0.004$) and less likely to be assigned to the warm-hand off treatment arm (37.7% vs. 50.9%, $p = 0.045$) than the participants who were not lost to follow-up. Descriptive statistics were calculated for the entire sample as well as stratified by smoking status (abstinent versus still smoking) and outcome (7DPP at 1-month and verified abstinence at 6-months). Logistic regression was used to assess the relationship of the predictor variables and outcome variables. Descriptive statistics for the entire sample and stratified by smoking cessation outcome are presented in Table 1 along with bivariate odds ratios.

We used multivariable logistic regression models to determine the adjusted odds of post-discharge treatment participation (use of counseling and medications) for short and long-term abstinence. In accordance with guidelines for logistic regression, factors with p -values < 0.25 were selected for inclusion in the multivariable logistic regression models (Hosmer and Lemeshow, 2000). Treatment arm, nicotine dependence, gender, age, health insurance and high-risk drinking (AUDIT-C) were included in the multivariable logistic regression models regardless of p -value as these are known confounders of cessation (Hyland et al., 2004). Intent-to-treat analysis was used,

Table 1
Descriptive statistics and bivariate associations.

	Total		7DPP at 1-month					Verified quit at 6-months				
			Abstinent	OR	[95% CI]	p-Value		Abstinent	OR	[95% CI]	p-Value	
Age, mean (SD)	49.78	(12.91)	50.69	(13.44)	1.01	[1.00, 1.02]	0.041	51.21	(13.0)	1.01	[1.00, 1.02]	0.034
Female, n (%)	547	(55.6)	256	(56.1)	1.04	[0.81, 1.34]	0.747	155	(58.1)	1.15	[0.86, 1.52]	0.343
Married, n (%)	374	(38.1)	175	(38.4)	1.02	[0.79, 1.32]	0.858	100	(37.6)	0.97	[0.73, 1.30]	0.863
White race, n (%)	697	(70.8)	318	(69.7)	0.91	[0.69, 1.19]	0.482	185	(69.3)	0.90	[0.66, 1.23]	0.515
Black race, n (%)	261	(26.5)	123	(27.0)	1.04	[0.79, 1.39]	0.767	69	(25.8)	0.95	[0.69, 1.31]	0.768
Race other, n (%)	63	(6.4)	30	(6.6)	1.06	[0.63, 1.76]	0.834	24	(9.0)	1.72	[1.01, 2.91]	0.045
Hispanic, n (%)	60	(6.1)	29	(6.4)	0.91	[0.54, 1.54]	0.728	21	(7.9)	0.68	[0.39, 1.17]	0.163
Education > HS	509	(51.7)	238	(52.2)	1.04	[0.80, 1.33]	0.786	158	(59.2)	1.51	[1.14, 2.00]	0.004
Health insurance, n (%)	928	(94.3)	435	(95.4)	1.47	[0.84, 2.56]	0.174	254	(95.1)	1.25	[0.66, 2.36]	0.498
Lives w/ other smoker, n (%)	489	(49.7)	218	(47.8)	0.87	[0.67, 1.12]	0.271	142	(46.8)	0.85	[0.64, 1.13]	0.271
CPD, median (IQR)	15	(13.0)	12	(13.0)	0.99	[0.98, 1.01]	0.385	10	(14.0)	0.99	[0.97, 1.00]	0.088
Smokes ≥ 25/30 days, n (%)	709	(72.1)	290	(63.6)	0.45	[0.34, 0.60]	< 0.001	164	(61.4)	0.50	[0.37, 0.68]	< 0.001
E-cig use in past 30 days, n (%)	117	(11.9)	49	(10.8)	0.81	[0.55, 1.20]	0.292	36	(13.5)	1.22	[0.80, 1.85]	0.360
Other tobacco use, n (%)	76	(7.7)	34	(7.5)	1.07	[0.67, 1.72]	0.770	16	(6.0)	1.43	[0.81, 2.53]	0.217
TTFC < 30 min, n (%)	705	(71.9)	315	(69.2)	0.78	[0.59, 1.03]	0.083	180	(67.7)	0.75	[0.55, 1.02]	0.067
HSI, mean (SD)	2.7	(1.65)	2.61	(1.69)	0.94	[0.87, 1.01]	0.119	2.51	(1.69)	0.91	[0.83, 0.99]	0.023
Confidence, mean (SD)	3.79	(1.12)	4	(1.05)	1.33	[1.18, 1.50]	< 0.001	3.93	(1.08)	1.18	[1.03, 1.34]	0.014
At risk for heavy drinking, n (%)	312	(31.7)	128	(28.1)	0.73	[0.56, 0.96]	0.023	70	(26.2)	0.70	[0.51, 0.95]	0.024
At risk for depression, n (%)	525	(53.4)	229	(50.2)	0.79	[0.61, 1.01]	0.063	141	(52.8)	0.97	[0.73, 1.28]	0.821
Tobacco-related disease diagnosis, n (%)	404	(41.1)	209	(45.8)	1.44	[1.12, 1.86]	0.005	123	(46.1)	1.33	[1.00, 1.76]	0.052
Psychiatric diagnosis, n (%)	318	(32.3)	122	(26.8)	0.62	[0.47, 0.81]	0.001	85	(31.8)	0.97	[0.72, 1.31]	0.844
Admitted through ED, n (%)	585	(59.5)	285	(62.5)	1.27	[0.98, 1.64]	0.070	162	(60.7)	1.07	[0.80, 1.43]	0.634
LOS (days), median (IQR)	3.84	(4.39)	4.71	(5.45)	1.09	[1.06, 1.26]	< 0.001	4.49	(4.46)	1.03	[1.00, 1.05]	0.036
Used meds post-hospitalization	264	(28.2)	144	(31.7)	1.39	[1.05, 1.85]	0.023	87	(33.5)	1.43	[1.04, 1.95]	0.026
Warm Handoff, n (%)	501	(50.9)	228	(50)	0.93	[0.73, 1.20]	0.594	134	(50.2)	0.96	[0.72, 1.27]	0.781
Quitline calls, median (IQR)	1	(3.0)	2	(4.0)	1.22	[1.13, 1.31]	< 0.001	2	(3.0)	1.30	[1.19, 1.41]	< 0.001
Abstinent at 1 mo, n (%)	–	–	–	–	–	–	–	201	(75.28)	5.52	[4.02, 7.58]	< 0.001

Note. 7DPP = seven-day point prevalence; OR = odds ratio; CPD = average cigarettes per day; TTFC = time to first cigarette; HSI = Heaviness of Smoking Index; ED = emergency department; LOS = length of stay; SD = standard deviation; IQR = interquartile range.

Study location: Kansas, USA; study date: 2011–2014.

non-responders at 1-month (4.4%) and 6-months (11.3%) were treated as smokers. Rates of missing data on the predictors in the sample were low (0.2–5%). Our outcome measure at 1-month differed from our outcome measure at 6 months (self-report 7DPP versus biochemically verified 7DPP abstinence). Multiple imputation with chained equations (MICE) using 20 imputed datasets was used for both bivariate and multivariable analyses (Royston and White, 2011). The analyses were performed Stata, version 14.1 (Stata Statistical Software: Release 14 [Computer Program], 2015).

3. Results

3.1. Sample characteristics

Baseline descriptive statistics for the overall sample and for smokers abstinent at one and six months are presented in Table 1. Primary reasons for hospitalization have been described in the main outcome paper (Richter et al., 2016). Bivariate odds ratios (OR) assessing the degree of association of each baseline predictor with each outcome are also presented in Table 1. By 1-month, 456 subjects (46.3%) reported 7DPP abstinence. At 6-months, 267 (27.1%) subjects were verified abstinent. The mean age of participants was 50 years, predominately female (56%), White (71%) and were likely to have with-the majority had some form of health insurance (94%). The median level of cigarette consumption was 15 CPD and 72% of the sample reported daily smoking (≥ 25/past 30 days). Seventy-two percent of the sample reported smoking within 30 min of waking.

With respect to post-hospitalization treatment engagement, 68.5% of all participants completed at least one quitline call, 28% of all participants reported using cessation pharmacotherapy, and 20% utilized both quitline services and cessation pharmacotherapy. Of participants who used pharmacotherapy, 85% used any form of nicotine replacement therapy, 79% used the nicotine gum or patch, 5% bupropion, and

12% varenicline.

3.2. Bivariate predictors of 1-month and 6-month abstinence

Both post-discharge medication use and counseling participation were associated with cessation outcomes. A greater total number of quitline calls completed was associated with a significantly greater likelihood of abstinence at 1-month (OR [95% CI] = 1.22 [1.13, 1.31], $p < 0.001$) and at 6-months (OR [95% CI] = 1.30 [1.19, 1.41], $p < 0.001$). Post-hospitalization pharmacotherapy use was also associated with abstinence at 1-month (OR [95% CI] = 1.39 [1.05, 1.85], $p = 0.02$) and six months (OR [95% CI] = 1.43 [1.04, 1.95], $p = 0.03$). Lastly, abstinence at 1-month was strongly associated with abstinence at 6-months (OR [95% CI] = 5.52 [4.02, 7.58], $p < 0.001$).

Among sociodemographic characteristics, education was the only significant factor at 6 months (Table 1). Having a tobacco-related disease diagnosis and not having a psychiatric diagnosis were significantly associated with the likelihood abstinence at 1-month, but not at six months. However, risk for heavy drinking, as measured using the AUDIT-C, was associated with a lower likelihood of abstinence at 1-month. With respect to nicotine dependence, HSI was significantly associated with cessation at 6-months.

Multiple participant characteristics were associated with the likelihood of abstinence at one and six months. Of the smoking related variables, daily smoking was inversely associated with abstinence at 1-month and 6 months. Likewise, confidence in post-hospitalization quitting was associated with abstinence at 1-month and 6 months. A longer length of stay (LOS) was also associated with abstinence at both one and six months.

3.3. Multivariable model results

The results from the multivariable logistic regression models are

Table 2
Multivariable model results.

	One-month 7DPP OR [95% CI]	Six-month verified quit OR [95% CI]
Warm handoff vs. fax referral	0.85 [0.64, 1.13]	0.86 [0.63, 1.20]
Age	1.00 [0.99, 1.01]	1.00 [0.99, 1.02]
Female	1.04 [0.78, 1.39]	0.97 [0.70, 1.34]
Has insurance	1.32 [0.72, 2.41]	0.87 [0.43, 1.76]
Other race		1.52 [0.80, 2.89]
Hispanic		0.69 [0.36, 1.33]
Edu. > high school		1.58** [1.15, 2.18]
Smokes ≥ 25/30 days	0.58** [0.42, 0.81]	0.63* [0.44, 0.90]
HSI	0.96 [0.88, 1.05]	0.95 [0.86, 1.05]
Confident	1.22** [1.07, 1.38]	1.02 [0.88, 1.18]
Used other tobacco products		1.42 [0.75, 2.67]
Alcohol use disorder	0.80 [0.59, 1.09]	0.82 [0.57, 1.18]
Possible depression	0.87 [0.65, 1.15]	
Psychiatric comorbidity	0.72* [0.54, 0.98]	
Tobacco-related disease diagnosis	1.46* [1.08, 1.96]	1.14 [0.81, 1.60]
ED admission	1.51** [1.14, 2.01]	
LOS (days)	1.09*** [1.06, 1.13]	1.00 [0.97, 1.03]
Used meds. post-discharge	1.45* [1.06, 1.99]	1.27 [0.89, 1.82]
Total quitline calls	1.25*** [1.14, 1.36]	1.23*** [1.12, 1.35]
Abstinent at 1 mo.		4.67*** [3.33, 6.54]

Note. OR = odds ratio; HSI = Heaviness of Smoking Index; ED = emergency department; LOS = length of stay; 7DPP = seven-day point prevalence; Meds = smoking cessation pharmacotherapy (NRT, varenicline, bupropion).

Study location: Kansas, USA; study date: 2011–2014.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

presented in Table 2. Both using cessation pharmacotherapy post-hospitalization as well as completing a greater number of quitline calls were associated with abstinence at 1-month. Other predictors included being a non-daily smoker, confidence, not having a psychiatric diagnosis, having a tobacco related disease diagnosis, admission through the emergency department (ED), and a longer length of hospital stay.

After controlling for abstinence at 1-month, completing a greater number of quitline calls was associated with 6-month verified abstinence. Other predictors included non-daily smoking, having greater than a high school education, and significantly associated with a greater likelihood of abstinence. The model results using 7DPP abstinence at 6-months were essentially identical, hence, we report the model with the stronger outcome measure (biochemically verified abstinence).

4. Discussion

When adjusting for known predictors of smoking cessation among hospitalized smokers (Lando et al., 2003), both post-discharge pharmacotherapy use and total number of quitline calls were associated with short-term cessation. Only quitline utilization was associated with long-term cessation. This is consistent with meta-analyses of hospital-based tobacco cessation studies (Rigotti et al., 2012) and adds to this literature by describing the independent effects of counseling and medication to quitting within the same treatment sample.

Of particular note, quitline call engagement remained predictive of cessation at 6-months even after adjusting for 1-month smoking cessation. Quitline counseling facilitates smoking cessation by increasing self-efficacy for cessation and developing skills related to coping with cravings (Schuck et al., 2014). This suggests that quitline counseling may have helped participants sustain their medication-assisted quit attempts, and might also be particularly effective for those making delayed quit attempts well after hospital discharge. One explanation for this may be that the motivational processes underlying the cessation-

promoting effects of ‘teachable moments’ that occur during hospitalization (McBride et al., 2003) may wane following discharge. Engaging in counseling could build on that teachable moment to bolster the self-efficacy and skills needed to quit at a later date. To improve utilization of counseling calls, hospitals should ensure patients receive cessation medications (which has been shown to increase call utilization) and prepare patients for follow-up calls from the quitline (Burns et al., 2012; Scheuermann et al., 2019).

Post-discharge use of cessation medication does not appear to have this same effect. Its effect appeared limited to supporting 1-month abstinence. After controlling for early abstinence it had no independent effect on 6-month abstinence. The novel feature of the present study is that we examined cessation at short and long term follow up, measured participation in both counseling and medications, and accounted for the effects of quitting at 1 month. No other studies, including the factorial design trial conducted by Cummins et al., controlled for the effects of early abstinence. This is perhaps why the study was able to distinguish between the effects of counseling and medications at 6 months.

The present study also contributes to the existing literature on barriers and facilitators related to smoking cessation among hospitalized smokers. Only one in four used medications post discharge. The relatively low rate of pharmacotherapy use is notable given the high rates of health insurance in this sample. Although most private and public insurers are required to cover cessation medications, compliance may not be consistent and some proportion of patients may not have used medications due to inability to get their prescriptions filled.

In addition, Similar to Bentz et al., we found that only two-thirds of participants, all of whom were referred to quitline, engaged in counseling (Bentz et al., 2006). The effects of confidence and smoking related-illness observed in the present analysis are consistent with other studies (Lando et al., 2003; MacKenzie et al., 2004). In addition, the effects of psychiatric diagnosis and longer length of hospital stay observed in the present analysis coincide with findings from a study of post-discharge smoking relapse among patients hospitalized for acute coronary syndrome (Perez et al., 2008).

In contrast to the present study, Cummins' (Cummins et al., 2016) factorial experiment achieved a marginal effect for post-discharge pharmacotherapy on 6-month cessation and a non-significant effect for quitline counseling. Findings may differ between studies due to different utilization patterns: Cummins' trial had a lower rate of post-discharge quitline counseling in the quitline arm (47%) versus the present study (68%) but achieved a higher rate of pharmacotherapy utilization (67%) than the current study (29%).

This study has several limitations. The relative contribution of pharmacotherapy and quitline services to cessation could not be definitively ascertained due to selection bias—participants were not randomly assigned to receive these interventions. The most motivated to quit, or able to do so, may have been more likely to use pharmacotherapy or engage in quitline services. We tried to control for this by adjusting for known predictors of cessation. In addition, the study recruited patients who intended to stay quit post-hospitalization. The findings may not generalize to other hospital settings or to patients who are not motivated to quit. In addition, we were not able to measure whether participants actually filled the prescriptions for medication they were discharged with, which could have been a meaningful predictor of cessation.

We were not able to test the phenomenon of reverse causation because of insufficient data to examine the temporal associations between individual counseling calls/medication use and smoking status longitudinally. It is possible that smokers who were having more success with quitting were more likely than those who relapsed to persist with medication use and counseling. Also, odds ratios generated from the multivariable logistic regression models might overestimate the strength of association.

5. Conclusions

Post-discharge counseling may have a latent effect on long-term cessation. The benefits of post-discharge pharmacotherapy and quitline services is contingent upon patients accessing and using these resources. Thus, enhancing smokers' uptake of pharmacotherapy and quitline services—and enhancing medication adherence and utilization of coaching calls—are important and synergistic strategies for improving the efficacy of hospital-initiated intervention.

Funding

This work was supported by funding from the NIH National Heart, Lung, and Blood Institute (U01 HL105232).

Declaration of Competing Interest

The authors have no conflicts of interest to disclose.

Acknowledgements

The authors acknowledge the support of Laura Mussulman, MPH and Niaman Nazir, MBBS, MPH in clarifying questions about the data.

References

- Bentz, C.J., Bayley, K.B., Bonin, K.E., Fleming, L., Hollis, J.F., McAfee, T., 2006. The feasibility of connecting physician offices to a state-level tobacco quit line. *Am. J. Prev. Med.* 30 (1), 31–37. <https://doi.org/10.1016/j.amepre.2005.08.043>.
- Burns, E.K., Levinson, A.H., Deaton, E.A., 2012. Factors in nonadherence to quitline services: smoker characteristics explain little. *Health Educ. Behav.* 39 (5), 596–602. <https://doi.org/10.1177/1090198111425186>.
- Bush, K., Kivlahan, D.R., McDonell, M.B., Fihn, S.D., Bradley, K.A., 1998. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory care quality improvement project (ACQUIP). Alcohol use disorders identification test. *Arch. Intern. Med.* 158 (16), 1789–1795.
- CDC, 2010. Vital signs: current cigarette smoking among adults aged > or = 18 years — United States, 2009. *MMWR Morb. Mortal. Wkly Rep.* 59 (35), 1135–1140.
- Cummins, S.E., Gamst, A.C., Brandstein, K., et al., 2016. Helping hospitalized smokers: a factorial RCT of nicotine patches and counseling. *Am. J. Prev. Med.* 51 (4), 578–586. <https://doi.org/10.1016/j.amepre.2016.06.021>.
- Duffy, S.A., Ronis, D.L., Karvonen-Gutierrez, C.A., et al., 2016. Effectiveness of the tobacco tactics program in the trinity health system. *Am. J. Prev. Med.* 51 (4), 551–565. <https://doi.org/10.1016/j.amepre.2016.03.012>.
- Fellows, J.L., Mularski, R.A., Leo, M.C., et al., 2016. Referring hospitalized smokers to outpatient quit services: a randomized trial. *Am. J. Prev. Med.* 51 (4), 609–619. <https://doi.org/10.1016/j.amepre.2016.06.014>.
- Fiore, M.C., Jaén, C.R., Baker, T.B., et al., 2008. Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline. U.S. Department of Health and Human Services. Public Health Service, Rockville, MD.
- Freund, M., Campbell, E., Paul, C., et al., 2008. Smoking care provision in hospitals: a review of prevalence. *Nicotine Tob. Res.* 10 (5), 757–774. <https://doi.org/10.1080/14622200802027131>.
- Harrington, K.F., Kim, Y.-i., Chen, M., et al., 2016. Web-based intervention for transitioning smokers from inpatient to outpatient care: an RCT. *Am. J. Prev. Med.* 51 (4), 620–629. <https://doi.org/10.1016/j.amepre.2016.04.008>.
- Heatherton, T.F., Kozlowski, L.T., Frecker, R.C., Rickert, W., Robinson, J., 1989. Measuring the heaviness of smoking: using self-reported time to the first cigarette of the day and number of cigarettes smoked per day. *Br. J. Addict.* 84 (7), 791–799.
- Hosmer, D.W., Lemeshow, S., 2000. *Applied Logistic Regression*, 2nd ed. John Wiley & Sons, New York.
- Hyland, A., Li, Q., Bauer, J.E., Giovino, G.A., Steger, C., Cummings, K.M., 2004. Predictors of cessation in a cohort of current and former smokers followed over 13 years. *Nicotine Tob. Res.* 6 (Suppl. 3), S363–S369.
- Lando, H., Henriksen, D., McCarty, M., Vessey, J., 2003. Predictors of quitting in hospitalized smokers. *Nicotine Tob. Res.* 5 (2), 215–222. <https://doi.org/10.1080/0955300031000083436>.
- MacKenzie, T.D., Pereira, R.I., Mehler, P.S., 2004. Smoking abstinence after hospitalization: predictors of success. *Prev. Med.* 39 (6), 1087–1092. <https://doi.org/10.1016/j.ypmed.2004.04.054>.
- McBride, C.M., Emmons, K.M., Lipkus, I.M., 2003. Understanding the potential of teachable moments: the case of smoking cessation. *Health Educ. Res.* 18 (2), 156–170.
- Perez, G.H., Nicolau, J.C., Romano, B.W., Laranjeira, R., 2008. Depression: a predictor of smoking relapse in a 6-month follow-up after hospitalization for acute coronary syndrome. *Eur. J. Cardiovasc. Prev. Rehabil.* 15 (1), 89–94. <https://doi.org/10.1097/HJR.0b013e3282f4b212>.
- Richter, K.P., Faseru, B., Mussulman, L.M., et al., 2012. Using “warm handoffs” to link hospitalized smokers with tobacco treatment after discharge: study protocol of a randomized controlled trial. *Trials*. 13 (127). <https://doi.org/10.1186/1745-6215-13-127>.
- Richter, K.P., Faseru, B., Shireman, T.I., et al., 2016. Warm handoff versus fax referral for linking hospitalized smokers to quitlines. *Am. J. Prev. Med.* 51 (4), 587–596. <https://doi.org/10.1016/j.amepre.2016.04.006>.
- Rigotti, N.A., Stoney, C.M., 2016. CHARTing the future course of tobacco-cessation interventions for hospitalized smokers. *Am. J. Prev. Med.* 51 (4), 549–550. <https://doi.org/10.1016/j.amepre.2016.07.012>.
- Rigotti, N.A., Clair, C., Munafò, M.R., Stead, L.F., 2012. Interventions for smoking cessation in hospitalised patients. *Cochrane Database Syst Rev.* 5, Cd001837. <https://doi.org/10.1002/14651858.CD001837.pub3>.
- Rigotti, N.A., Regan, S., Levy, D.E., et al., 2014. Sustained care intervention and post-discharge smoking cessation among hospitalized adults: a randomized clinical trial. *JAMA* 312 (7), 719–728. <https://doi.org/10.1001/jama.2014.9237>.
- Rigotti, N.A., Tindle, H.A., Regan, S., et al., 2016. A post-discharge smoking-cessation intervention for hospital patients: helping hand 2 randomized clinical trial. *Am. J. Prev. Med.* 51 (4), 597–608. <https://doi.org/10.1016/j.amepre.2016.04.005>.
- Royston, P., White, I.R., 2011. Multiple imputation by chained equations (MICE): implementation in Stata. *J. Stat. Softw.* 45 (4), 20. <https://www.jstatsoft.org/v045/i04/10.18637/jss.v045.i04>.
- Scheuermann, T.S., Preacher, K.J., Carlini, B.H., et al., 2019. Predictors of engagement in post-discharge quitline counseling among hospitalized smokers. *J. Behav. Med.* 42 (1), 139–149. <https://doi.org/10.1007/s10865-018-9951-6>.
- Schuck, K., Otten, R., Kleinjan, M., Bricker, J.B., Engels, R.C., 2014. Self-efficacy and acceptance of cravings to smoke underlie the effectiveness of quitline counseling for smoking cessation. *Drug Alcohol Depend.* 142, 269–276. <https://doi.org/10.1016/j.drugalcdep.2014.06.033>.
- Sherman, S.E., Link, A.R., Rogers, E.S., et al., 2016. Smoking-cessation interventions for urban hospital patients: a randomized comparative effectiveness trial. *Am. J. Prev. Med.* 51 (4), 566–577. <https://doi.org/10.1016/j.amepre.2016.06.023>.
- Simon, J.A., Solkowitz, S.N., Carmody, T.P., Browner, W.S., 1997. Smoking cessation after surgery. A randomized trial. *Arch. Intern. Med.* 157 (12), 1371–1376.
- SRNT, 2002. Biochemical verification of tobacco use and cessation. *Nicotine Tob. Res.* 4 (2), 149–159. <https://doi.org/10.1080/14622200210123581>.
- Stata Statistical Software: Release 14 [Computer Program]. College Station, TX.
- Stead, L.F., Hartmann-Boyce, J., Perera, R., Lancaster, T., 2013. Telephone counselling for smoking cessation. *Cochrane Database Syst. Rev.* 8, Cd002850. <https://doi.org/10.1002/14651858.CD002850.pub3>.
- Wier, L.M., Pfuntner, A., Maeda, J., et al., 2011. CUP Facts and Figures: Statistics on Hospital-based Care in the United States, 2009. 2011 Agency for Healthcare Research and Quality, Rockville, MD. <http://www.hcup-us.ahrq.gov/reports.jsp> (Accessed June 27, 2019).